Trigno® Wireless Biofeedback System

Trigno Centro Base Station

User's Guide

MAN-049-0-1

Important Information

Intended Use

The Trigno Wireless Biofeedback System is an instrument consisting of the following key items:

- battery-powered wireless biofeedback sensors
- a sensor recharge unit
- a base station receiver
- a commercial PC with USB communication or similar computing device
- software

The device enables researchers and clinicians to acquire electromyographic and related signals from participants for academic, clinical, and scientific study, education, fitness and general wellness purposes. Outputs of the system are to be interpreted by qualified individuals educated in the understanding of physiological signals and human movement.

The device is intended for research use only, and not intended for diagnosing, treating, mitigating disease or direct patient therapy.

Participant Precautions

⚠️ DO NOT USE on Participants with implanted electronic devices of any kind, including cardiac pace-makers or similar assistive devices, electronic infusion pumps, and implanted stimulators.

⚠️ DO NOT USE on irritated skin or open wounds.

⚠️ DO NOT USE on Participants with allergies to silver.

⚠️ DO NOT USE in critical care applications.

Technical Service and Support

For information and assistance please visit our web site at:
www.delsys.com
Contact us at:
E-mail: support@delsys.com
Telephone: (508) 545 8200

Warnings and Precautions

Consult all accompanying documents for precautionary statements and other important information.

Consult accompanying user's guide for detailed instructions.

Keep the device dry. The ingress of liquids into the device may compromise the safety features of the device.

Handle with care.

Sensitive electronic device. Avoid static discharges. Do not operate or store near strong electrostatic, electromagnetic, magnetic or radioactive fields. Interference from external sources may decrease the signal-to-noise ratio or result in corrupted data.

Connect only to Delsys-approved devices.

Connecting a patient to high-frequency surgical equipment while using Delsys EMG systems may result in burns at the site of the EMG sensor contacts

Immediately discontinue device use if skin irritation or discomfort occurs.

⚠ Immediately discontinue device use if a change in the device's performance is noted.   Contact Delsys technical support for assistance.

⚠ Delsys Inc. guarantees the safety, reliability, and performance of the equipment only if assembly, modifications and repairs are carried out by authorized technicians; the electrical installation complies with the appropriate requirements; and the equipment is used in accordance with the instructions for use.

⚠ Device contains a Lithium-Polymer battery. Do not damage, crush, burn, freeze or otherwise mishandle the device. Recharge only with the approved power supply and recharger.

⚠ Report any serious incidents with the device to Delsys at 508 545 8200 or support@delsys.com.

Trigno Systems should be stored and operated between 5 and 45 degrees Celsius due to the presence of an internal Lithium Polymer rechargeable cell. Storing or operating the device, and consequently the cell, outside of this temperature range may compromise the integrity and the safety features of the cell.

Device Information

CE Complies with Requirements put forth by the Medical Device Regulation EU 2017/745. Class I device, Annex VIII. Type BF device (IEC 60601-1)

□ Isolated device, (Class II, IEC 60601-1)

⚕ (Type BF symbol)	Type BF Equipment.
ᨆ (Date of Manufacturing symbol)	Date of Manufacturing (appears on device)
■ (Manufacturer symbol)	Manufacturer: Delsys Inc. 23 Strathmore Rd. Natick, MA, 01760, USA
ᨆ USA (Made in USA symbol)	Made in the USA, Country of Origin USA
SN	Serial Number (appears on device)
REF	Catalog Number: SP-W10
#	System Number: DS-T04
⌧ (WEEE symbol)	Dispose the device according to local rules for electronic waste.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Reorient or relocate the receiving antenna; increase the separation between the equipment and receiver; Connect the equipment into outlet on a separate circuit.

Pursuant to FCC 15.21 of the FCC rules, changes not expressly approved by Delsys Inc. could void the User's authority to operate the equipment.

⚠ This product complies with FCC & Industry Canada's RSS-102 radiation exposure limits set forth for an uncontrolled environment.

Ce produit est conforme à la norme FCC et aux limites d'exposition au rayonnement RSS-102 d'Industrie Canada définies pour un environnement non contrôlé.

Trigno System Overview

The Trigno[®] Wireless Biofeedback System is a device designed to make EMG (electromyographic) and biofeedback signal detection reliable and easy. The system transmits signals from Trigno Avanti sensors to the Trigno Centro receiving base station using a time-synchronized wireless protocol that removes data latency across sensors. The core architecture of the Trigno System is designed to support high fidelity EMG signals, along with complementary biofeedback signals such as movement data, force signals, contact pressure events, and timing/synchronization information. The system is capable of integrating with 3rd party instruments through a variety of interfaces including analog signal generation, digital triggering, and software integrations through the Trigno SDK (Software Development Kit) and the Trigno API (Application Program Interface). Refer to the specific system component sensor User Guide for operational details of these system elements.

Trigno Centro Base Station

The Trigno Centro Base Station is the communicating unit for the Trigno Avanti sensors, capable of securing a continuous synchronized data stream of up to 32 sensors. It can also synchronously digitize up to 6 user-configurable analog signals as well as a microphone input. Four user-configurable digital I/O channels for device synchronization functions and event marking are available. Control of the Centro Base Station is managed by Trigno Discover® software or the user-programmable Trigno® API over a USB port.
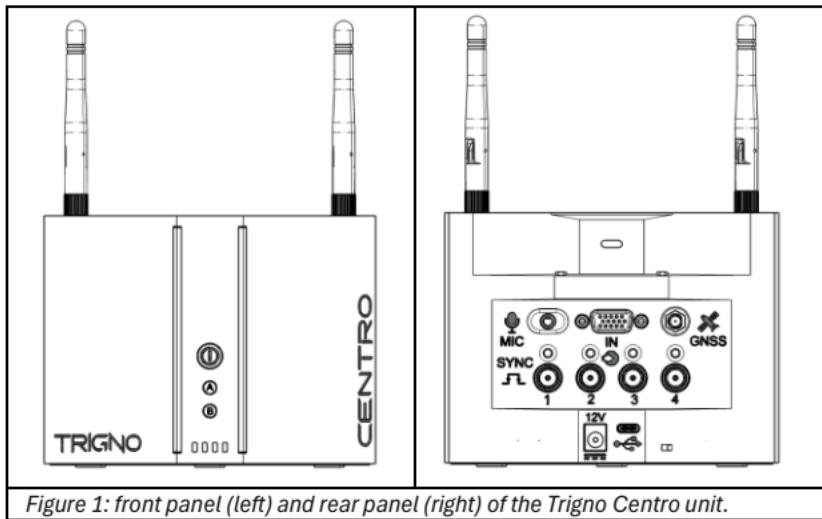
Figure 1: front panel (left) and rear panel (right) of the Trigno Centro unit.

Trigno® Centro Features:

- support for 32 Trigno Avanti sensors
- high speed USB communication with PC
- medical grade power supply
- GNSS data timestamp capability
- dedicated event marking buttons

- four configurable trigger channels
  - data start/stop function
  - event marker function
  - +/-5V or +/-3V logic or TTL
  - high impedance input or low impedance output function
  - configurable rising or falling edge detection
  - pushbutton trigger bypass
  - BNC connectors with LED state feedback

- six user-configurable analog inputs
  - +/-10V analog signal input range
  - 24-bit analog signal resolution
  - max analog sampling rate of 50 sa/sec
  - 3.5mm condensing mic input

32-Sensor Capability

The Trigno Centro Base Station supports a wireless communication protocol that can support a maximum of 32 Trigno Avanti sensors while maintaining full time synchronization between them indefinitely. The wireless communication operates in the 2.4GHz band and creates frequency and spatial redundancy across the RF band and across the two antennas at the top the unit.

Pushbutton Event Marking

Two pushbuttons labelled "A" and "B" on the front panel of the Centro unit can be used to create data markers during data streaming.
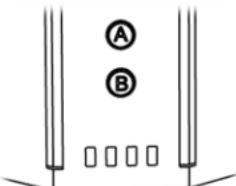
Figure 2: Pushbutton Data Markers.

GNSS Time Stamping

The Trigno Centro unit has a built-in GNSS receiver that is configured to record a universal time reference from the Global Navigation Satellite System. This provides a mechanism for data from any system in any location with access to GNSS time reference to be synchronized with data from the Centro unit. An antenna connector on the back of the unit can be used to connect an external GNSS antenna for improved reception in cases where a lock

Figure 3: External Antenna Port for GNSS Timestamping.

proves difficult. The Trigno Centro unit does not store positional information.

Trigger Functions

Four BNC connectors on the back panel of the unit can be configured in software to act as start triggers or stop triggers. Signals from other devices can be used start or stop data streaming from the sensors. Shunting the BNC or depressing the pushbutton for each BNC will manually trigger the channel.

Figure 4: Configurable BNC trigger channels with pushbutton activators.

Additionally, the channels can be configured as outputs so that other devices can be started and stopped from the Trigno Centro unit. The trigger channels can be configured to operate with 3V logic or 5V logic or TTL. Four LEDs on the front panel indicate the voltage status detected on the BNC: "high" is shown as white and "low" is shown as blue. Options for a sync output pulse can be configured to drive a continuous clock pulse train to drive a clock input for other devices. The clock pulse is synchronized to the wireless sensors data frames and ranges between 500 us to 1 sec and has a settable phase shift. Please see the Trigger Configuration section for additional details on these features.

Trigger Signal Feedback

The 4 LEDs on the front panel relay the voltage state on the 4 BNC Trigger channels. A low state (i.e. 0V) is shown as blue and a high state (i.e. 3V or 5V) is shown as white. LEDs that are off indicate that no trigger function has been configured. The purpose of this visual feedback is to give a simple indication of the voltage activity occurring on the trigger channels so that system operators can easily confirm interfacing strategies with other equipment.
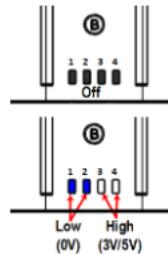

Figure 5:Trigger State LEDs.

Analog Signal Inputs

| Ch.¤	Pin¤	¤	Ch.¤	Pin¤
+IN1¤	5¤	¤	-IN1¤	10¤
+IN2¤	15¤	¤	-IN2¤	14¤
+IN3¤	7¤	¤	-IN3¤	2¤
+IN4¤	1¤	¤	-IN4¤	6¤
+IN5¤	9¤	¤	-IN5¤	4¤
+IN6¤	8¤	¤	-IN6¤	3¤
Trigger¤	11¤	¤	GND¤	13¤
NOT-CONNECTED¤				12¤
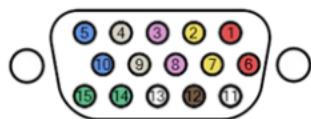
Figure 6: DSUB 15F Analog Signal Connections

The Centro unit can sample analog signals at an aggregate rate of 48,000 samples per second, time synchronized with the wireless sensor data. This data rate can be directed to one channel or split between a maximum of 6. The Centro unit supports 5 input ranges, spanning ±10V to ±0.01V which can be selected to maximize the signal to noise ratio for a given input. The inputs can be configured as differential or single ended signals and are accessed via a ubiquitous DSUB-15 connector. A configurable trigger channel is included on the connector to facilitate multi-signal connections for a wide array of applications.

Microphone Input

The Centro device is equipped with a 3.5mm jack to accept a condensing microphone input for sampling voice and sound in a time-synchronized way with the wireless sensor data. Operating the microphone input suspends operation of the 6 analog input channels available on the DSUB-15 connector. Microphone data are sampled at 48,000 samples/sec, with 24 bits of resolution.

Figure 7: 3.5 mm condensing microphone

Power & USB Connection

The Centro unit is supplied with the universal SC-P09 medical grade 12-volt power supply which connects to the device with the 2.1mm barrel jack on the rear panel.   In addition to the Centro base station, this power supply is also used for the the Charge-4 and Charge-16 recharge units.

The Centro base station communicates with a PC over the USB-C connector located on the rear panel next to the power supply jack.
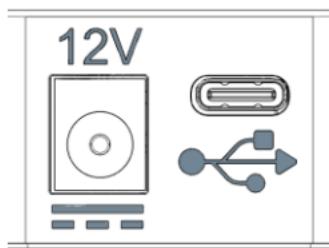
Figure 8: Power and USB -C jacks.

Trigno Centro LED States

The Trigno Centro front panel LEDs indicate the device's operational modes as described below:

MODE: Off Color: Off Pattern: Off Power is unplugged from the device.	
MODE: Standby Power Color: White Pattern: Solid (footer) Power is connected but device is dormant.	
MODE: Booting Color: White Pattern: Flash (3x/sec) Flash (1x/sec) Device is initializing on power up.	
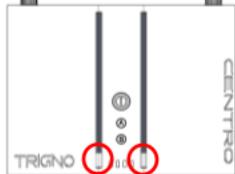
MODE: Idle Color: Amber Pattern: Solid Device is ready to start data streaming.	

MODE: Data Streaming Color: Green Pattern: Flash (1x/sec) Data from sensors are streaming to the device.	

MODE: Pairing Color: Cyan Pattern: Solid Device is actively pairing with a sensor.	

MODE: File Transfer Color: Blue Pattern: Flash (2x/sec) Files are transferring between PC and device over USB.	
MODE: Firmware Update Color: Magenta Pattern: Flash (~2x/sec) Firmware is updating on sensors or base station.	
MODE: Internal Error Color: Red Pattern: Flash (~3x/sec) Device experienced an internal communication error.	
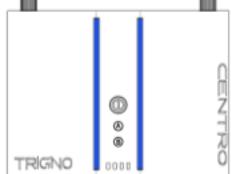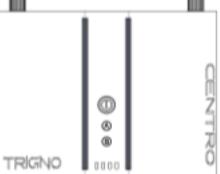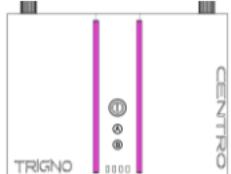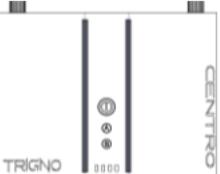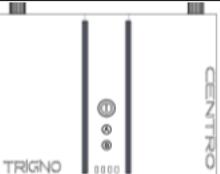
Power Button

Tapping the power button will begin the Centro boot process which takes approximately 34 seconds. Holding the button for 3 seconds or more will power down the device. Holding the button for 12 seconds or more will initiate a forced reset of the device.

Figure 9: Power Button

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Getting Started with the Trigno System

Initializing the Centro Base Station

Trigno Systems are equipped with a universal medical power supply and are provided with country-specific power cables. Connect the Trigno SC-P09 power supply to the circular DC jack located on the back of the Centro Base Station. Energize the power supply by connecting it to a mains outlet or to an isolation transformer. The device will enter standby mode, indicated by white LEDs on the base of the front panel.

Trigno Systems are specifically designed and approved to function only with the Trigno medical power supply provided. Power supply substitutions constitute a violation of the medical safety approvals and will void the warranty.

Computers requiring a connection to mains outlets must do so through use of a medically-certified isolation transformer in order to maintain the IEC60601-1 medical safety ratings of the system.

Connect the USB cable to the to the jack on the back panel of the Centro Base station and to the PC. Initiate the Centro boot process by depressing the power button on the front panel. The device LEDs will blink white during boot up and glow amber once completed. Initiate the Trigno Discover ® software to connect and configure the unit.

PC Software Installation

Trigno Discover software for Microsoft Windows can be downloaded from the Delsys website (www.delsys.com). Acquiring data with a PC requires the Trigno Centro Base Station or the Trigno Lite USB Adapter to be connected via the USB port. The Trigno System uses a custom RF protocol to guarantee high data bandwidth across a maximum of 32 sensors with no inter-sensor latency. Refer to the software user guide and help information for a detailed explanation of software functions. Data collection and sensor configuration is initiated through the software.

Configuring Wireless Communication

Transmission Frequencies

Wireless communication occurs on varieties of frequencies throughout the acceptable 2.4 GHz spectrum. Four frequency sets are available ("A", "B", "C" and "D") so that accommodations for RF crowding or RF noises can be made in a given environment.

Frequency Set A: creates an allowance from 2416-2451 MHz for standard 802.11 (WiFi) channels 5, 6, & 7

Frequency Set B: creates an allowance from 2421 – 2441, 2443-2483 MHz for standard 802.11(WiFi) channels 5, 9,10,11, 12, 13, & 14.

Frequency Set C: creates an allowance from 2400-2446 MHz for standard 802.11 (WiFi) channels 1,2,3,4,& 5.

Frequency Set D: creates an allowance from 2409-2461 MHz for standard 802.11 (WiFi) channels 3,4, 5, 6, 7, & 8.

Changing the communication frequency of the system requires all sensors to be re-paired to the base station for proper operation.

Configuring Sync Triggers on the Centro Base Unit

Trigger Inputs

An input trigger signal from a 3rd party device can be connected to any one of the BNC connectors on the rear panel of the Trigno Centro unit. Using the Trigno Discover Software, the selected BNC connector can be configured to support 3.3V logic or 5.0V logic and once armed can configured to act on a rising edge or a falling edge.

> ⚠️ BNCs are galvanically connected to the chasis of the operating PC. To maintain full electrical isolation and compliance to IEC60601-1 medical safety standards, the PC operating the Trigno Centro unit and the 3rd party device connected to the BNC trigger must be fully isolated from mains power by an IEC60601-1 approved isolated power source.

Start Trigger Input

A BNC configured as a start signal input will commence data acquisition and storage at the instance the signal edge is detected. Only one BNC can be configured as a start input at any time.
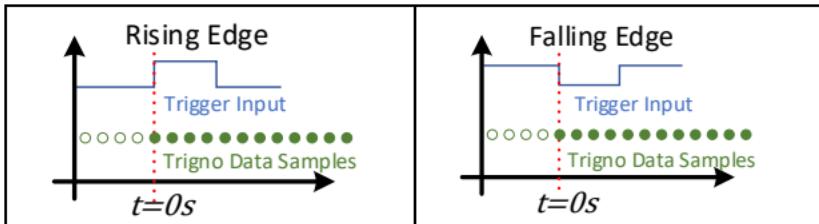
Figure 10: Start Trigger Input data sample timing for rising or falling signal edges.

Stop Trigger Input

A BNC configured as a stop signal input will immediately stop data acquisition at the instance the signal edge is detected. Only one BNC can be configured as a stop input at any time.
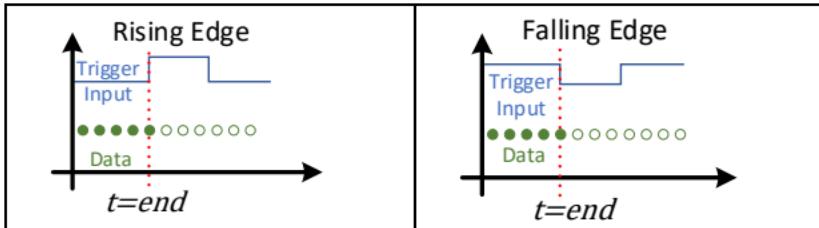

Figure 11: Stop Trigger Input data sample timing for rising or falling signal edges.

Single Input Start/Stop Trigger

A single BNC can be configured as a combined start and stop trigger input. In this configuration the first pulse received initiates data collection and a second received pulse stops data collection. As with other trigger configurations options for voltage levels and edge definition of rising or falling apply. Once a trigger BNC input is configured in this way no other input BNCs can be configured.
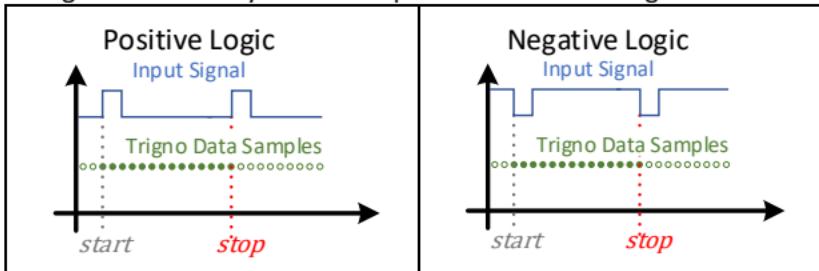
Figure 12: Single input start/stop trigger.

Windowed Trigger

A BNC can be configured to control data acquisition from a windowed signal, with the leading edge starting data acquisition and the trailing edge stopping acquisition. The window width of the signal determines the duration of the data collection. As with other trigger options, 3.3V/5.0V voltage levels and positive/negative configurations are available. Once a windowed trigger input is defined, no other trigger pathways can be configured as inputs.
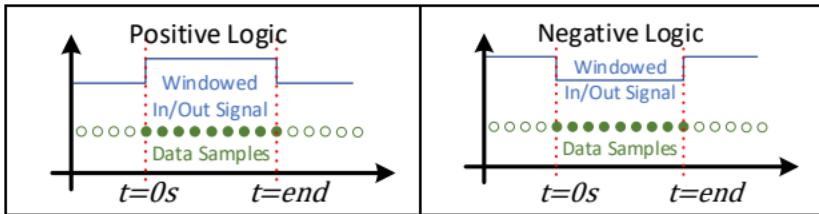
Figure 13: Windowed Trigger Input defining data acquisition duration by window width.

Trigger Input Manual Override

For any Trigger BNC configured as an input, a signal can be generated manually by pushing the tactile button switch associated with the corresponding BNC on the back panel. Depressing the button generates a rising edge signal and releasing the button generates a falling edge signal. This can be easily used to test trigger input configurations and manually trigger the system as an alternative to an electrical signal pulse.

Trigger Outputs

An output trigger signal for 3rd party devices can be connected to any one of the BNC connectors on the rear panel of the Trigno Centro unit. Using the Trigno Discover Software, the selected BNC connector can be configured to support 3.3V logic or 5.0V logic and once armed can be configured to generate a rising edge or a falling edge signal at the moment of data acquisition start or data acquisition stop.

> ⚠ BNCs are galvanically connected to the chasis of the operating PC. To maintain full electrical isolation and compliance to IEC60601-1 medical safety standards, the PC operating the Trigno Centro unit and the 3rd party device connected to the BNC trigger must be fully isolated from mains power by an IEC60601-1 approved isolated power source.

Start Trigger Output

A BNC configured as a start signal output will generate a signal edge at the moment the first data sample is captured. Only one BNC can be configured as a start output at any time.
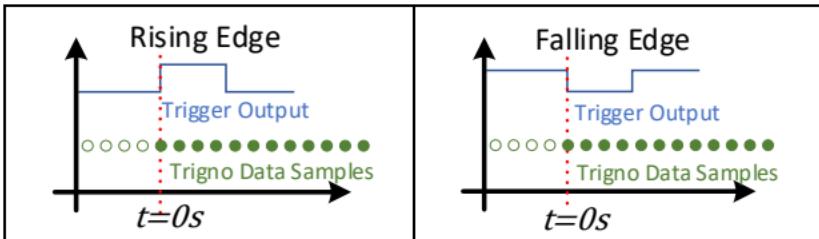
Figure 14: Start Trigger output signal timing for rising or falling signal edges.

Stop Trigger Output

A BNC configured as a stop signal output will generate a signal edge at the same time the last data sample is acquired. Only one BNC can be configured as a stop output at any time.
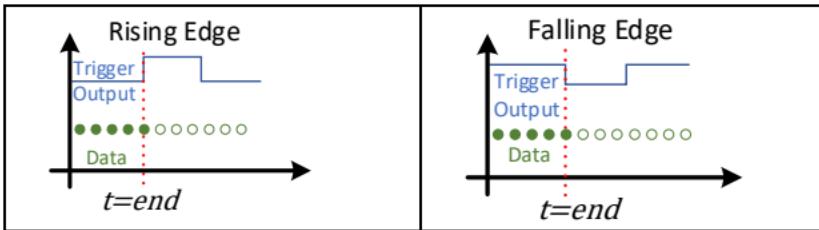
Figure 15: Stop Trigger output signal timing for rising or falling signal edges.

Event Marking Inputs

The Trigno Centro unit offers data marking options to indicate moments of interest during data collections. Users can manually mark data using the "A" marker channel or the "B" marker channel by manually pushing the corresponding buttons on the front panel of the Centro device. The moments in time will be correspondingly marked as user-defined events of interest in the recorded data sets. Separately, BNC connectors on the rear panel of the Centro device can be configured as inputs to mark time events from 3rdparty devices. As with Triggers signals, these inputs can be configured for 3.3V or 5.0V logic. Bosth rising and falling edges will be marked in the data. No more than 2 BNC inputs can be configured as event markers at any given time.

Configuring Analog Inputs on the Centro Base Unit

The Trigno Centro unit supports up to 6 analog inputs which are sampled in synchrony with Trigno Sensor data. The aggregate analog input sampling rate is 48,000 samples/sec with a max resolution depth of 24 bits. The aggregate data rate is divided amongst the configured channels according to the table below:

Configured Channel	Sampling Rate per channel
1	48,000 sa/sec
1,2	24,000 sa/sec
1,2,3,4	12,000 sa/sec
1,2,3,4,5,6	6,000 sa/sec

Table 1: Sampling rates as a function of number of input channels enabled.

⚠️ The analog input connector is galvanically connected to the chasis of the operating PC. To maintain full electrical isolation and compliance to IEC60601-1 medical safety standards, the PC operating the Trigno Centro unit and the 3rd party device connected to the anlaog input connector must be fully isolated from mains power and comply with IEC60601-1 requirements.

The voltage input range of each channel can be tuned to maximize bit resolution and SNR based on the expected signal amplitude range.

Performance between differential input and single-ended input is demarcated.

Single Ended Connection

Input Range	Noise Floor ($V_{rms(r.t.i.)}$)	Resolution (r.t.i.)
± 10 V	657 uV	1.42 e-6
± 5 V	318 uV	1.42 e-6
± 1 V	7.4 uV	1.22e-7
± 0.1 V	0.12 uV	1.22e-7
± 0.01 V	0.017 uV	2.77e-9

Differential Connection

Input Range	Noise Floor ($V_{rms(r.t.i.)}$)	Resolution (r.t.i.)
± 10 V	657 uV	1.42 e-6
± 5 V	318 uV	1.42 e-6
± 1 V	7.4 uV	1.22e-7
± 0.1 V	0.12 uV	1.22e-7
± 0.01 V	0.017 uV	2.77e-9

Table 2: Scaling options for multiplying (1-75) or dividing (1-27) the native 13.5ms data synchronization period of the system.

Differential and Single Ended Analog Input Configurations

Native access to each signal input is for a differential configuration. Shielding is recommended for each differential pair connected to the

input. Shielding should be connected to the ground pin of the analog input connector. Single ended signals can be easily connected by using the positive (non-inverting) input of each channel and connecting the negative (inverting) pin of the connector to ground.

Differential Setup

Pin	CH+	CH-	Pin
5	+IN1	-IN1	10
15	+IN2	-IN2	14
7	+IN3	-IN3	2
1	+IN4	-IN4	6
9	+IN5	-IN5	4
8	+IN6	-IN6	3
		GND	13

Single Ended Setup

Pin	CH+	CH-	Pin
5	+IN1	GND	10
15	+IN2	GND	14
7	+IN3	GND	2
1	+IN4	GND	6
9	+IN5	GND	4
8	+IN6	GND	3
		GND	13

Table 3: Differential analog input connections (left side); Single ended analog input connections (right side).

Differential Connections	Single-Ended Connections
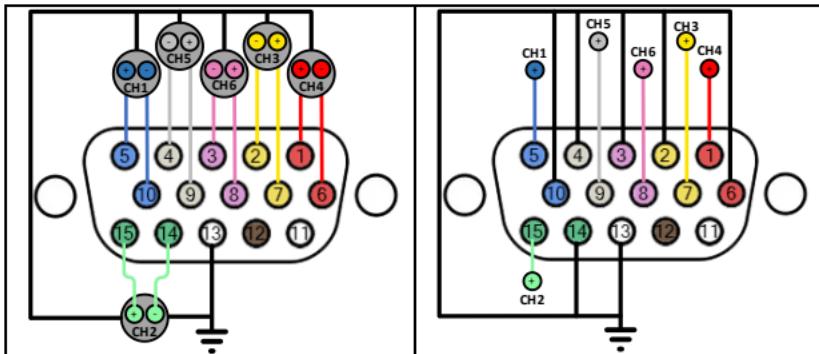
Figure 16: Connecting the Analog Inputs in a differential configuration (left) and single ended configuration (right).

Analog Input Connector Trigger

For increased accessibility a trigger signal connection is available on the DSUB-15 connector supporting the analog input signals. Configuration of the trigger channel matches configuration options of the BNC trigger channels.

Maintenance and Care

Trigno Centro Base Station

While the Base Station enclosure is made of durable polycarbonate plastic, the following points should be kept in mind during its use and handling.

- The device and its accessories should be visually inspected before every use to ensure that no mechanical deterioration has occurred.
- The Centro Base Station can be easily cleaned with isopropyl alcohol swabs if necessary. Do not expose the base station to any liquid; It is not a sealed device.
- The units should not be dropped or subjected to excessive forces of impact or acceleration.

⚠ The Centro Base Station is not water-resistant. Under no circumstances should this unit be exposed to water or any other type of liquid.

⚠ Only power the Centro Base Station with the supplied Trigno System power supply. Using an unapproved power supply may dammage the system and may negate the saftey features of the system.

Appendix I

Mains Isolation

The Trigno Base Station is provided with a medical grade isolated power supply that is compliant with the IEC60601 series of harmonized standards for Medical Devices. However, full compliance with IEC60601-1 Basic Safety for Medical Devices mandates the PC operating the software to be isolated as well. This stems from the basic requirement to have all participants and operators electrically isolated from equipment.

⚠	Delsys does not supply isolation transformers for Personal Computers and their peripherals.
⚠	Delsys recommends model IS1000HG manufactured by Tripp Lite (www.tripplite.com) for this task. This device is a medical grade isolation transformer capable of delivering up to 1000 W. A smaller similar version for 500W is also available (IS500HG). Similar products compliant with IEC60601-1 are acceptable.